

The Meteorological Magazine



Air Ministry :: Meteorological Office

Vol. 66

Dec.,
1931

No. 791

LONDON: PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

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The Abnormal Weather of November, 1931

The month of November, 1931, was characterised by persistent southerly and south-westerly winds and generally mild weather. In the first half of the month a series of violent gales swept the south coast of England, but after the 16th the conditions became quieter and the month ended in a spell of anticyclonic weather and widespread fog. The chart of deviations of pressure from normal, reproduced in fig. 1, shows a highly abnormal distribution. Pressure was more than 15 mb. below normal over Iceland, the deficit reaching 18.3 mb. at Reykjavik, while over northern and central Russia pressure was much above normal, the excess being 12.4 mb. at Moscow and probably still greater further to the north. This intense and persistent anticyclone prevented depressions from following their normal course to the eastward, and throughout the month a series of disturbances travelled towards the north-east along or off our western coasts.

The month opened brilliantly, most places in the south having more than eight hours' sunshine on the 1st, but a disturbance appeared on the 2nd, and by the 3rd a complex depression lay to the north-west of Ireland and Scotland, and in conjunction with an anticyclone over southern Europe caused gales and strong winds from between south-west and south over the southern half of England and Ireland.

Heavy rain fell in Wales and north-west England on both

the 2nd and 3rd. The records at present available may be tabulated as follows:—

	Nov. 2.	Nov. 3.	Total
<i>Lake District.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>
Borrowdale (Rosthwaite) ...	2·35	5·24	7·59
Keswick	2·44	4·64	7·08
Patterdale	3·15	5·50	8·65
Rydal	1·85	5·41	7·26
<i>Elan Valley.</i>			
Birmingham Water Works— (Nantgwillt)	1·16	3·90	5·06
<i>Carmarthen.</i>			
Black Mountains (Llyn-y-fan Fach)	2·16	6·52	8·68
<i>Brecon.</i>			
Trecastle (Blaenau-hydfder) ...	2·36	7·25	9·61
<i>Devon.</i>			
Ashburton (Holne)	0·58	4·52	5·10

The rain began a little before midnight on the 2nd, and the heavy totals were therefore concentrated within 36 hours. In Patterdale three inches fell in three hours. Serious flooding developed; Derwentwater and Bassenthwaite, which are about five miles apart, were joined in one great lake, and landslides occurred in the mountains, one of them over an area of two acres. In the Elan Valley on November 3rd and 4th, 2,855 million gallons of water were discharged into the Elan River at Caban Dam. This is the greatest amount in 48 hours since records began in 1908; had the reservoir been full at the beginning of the flood the discharge would have amounted to 3,105 million gallons. At Cranmere Pool, Dartmoor, the total rainfall during the first week of November amounted to 11·50 inches.

The rainfall amounts were unusually large, although not unprecedented for the British Isles. This type of rainfall distribution with very large falls in the mountainous districts of the west is generally associated with strong winds from the south-west. Serious floods were also recorded in Norway.

A depression of exceptional intensity appeared off western Ireland on the 9th, the barometer reading at Blacksod Point being 961·0 mb. at 13h. on the 10th. A violent gale raged in the Channel throughout this day and the morning of the 11th, and a great deal of damage was done along the south coast by the conjunction of rough seas and an exceptionally high tide. Houses on the shore were battered by the waves. The famous Ship Inn at Winchelsea was partly destroyed; a great lagoon covered the low-lying ground from Winchelsea beach to Rye Harbour, in which furniture was floating about, and the road was four feet under water. At Bungalow Town, Shoreham-by-Sea, about one hundred bungalows were destroyed or damaged,

some of the floors being covered by six inches of shingle. Part of the Isle of Wight west of the river Yar and Freshwater Bay was completely cut off from the rest of the island at high tide. In Wales heavy rain fell, and great damage was done by floods.

On the morning of the 11th the depression was centred over northern Scotland, and had already decreased considerably in intensity, and by the 12th it lay far to the north and had ceased to influence the British Isles and a short period of sunny weather occurred. Subsequently the disturbances followed a course far out in the Atlantic, but on the 14th a small secondary caused

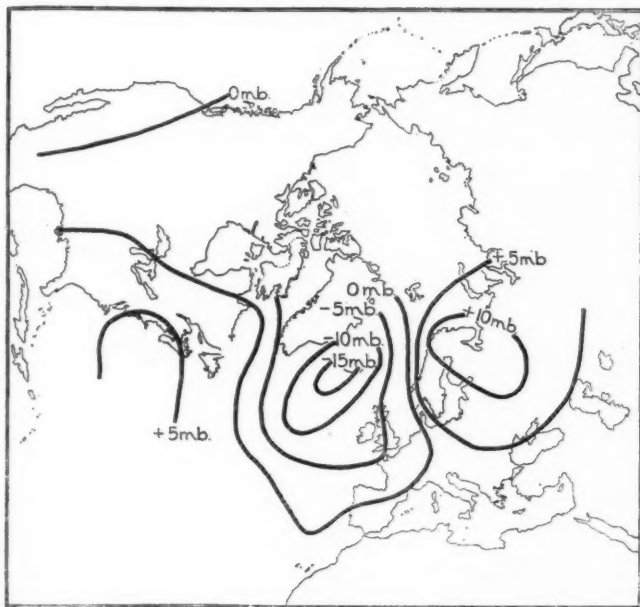


FIG. 1.

heavy rain in Wales and the Isle of Man; 2.42 inches of rain fell at Douglas, Isle of Man, in 22 hours on the 13th and 14th. On the 15th an anticyclone extended from Norway across the British Isles, and a short spell of fair weather occurred. On the 17th, however, fog occurred in many parts of eastern England, especially in the Thames Estuary. The 21st was generally sunny, but the fine spell ended on the 22nd, when a deep secondary to a complex depression in the North Atlantic travelled north-eastward across the country, causing strong winds and heavy rains in Ireland and the western parts of Great

Britain. Among the heavy falls on the 23rd were 2.81 inches at Ballinacurra, Co. Cork, 1.75 inches at Springburn Park, Glasgow, and 1.61 inches at Aberdeen. There was serious flooding in several parts of Scotland, in western Ireland and again in the Isle of Man. Another secondary passed over on the 29th, giving further heavy rain in south-east England. In the rear of this disturbance pressure rose rapidly as an anticyclone spread in from the south-west, and the accompanying light winds favoured the development of widespread fog over most of England and southern Scotland.

In addition to gales and floods, the month was characterised by generally high temperature. At Kew the average for the month, 46.8°F., was 2.5°F. above normal, and the night of the 3rd to 4th, on which the minimum temperature was 57°F., was the warmest November night for at least 60 years.

The abnormally high temperatures extended over the whole of western and northern Europe; the following figures show the average temperatures in November, 1931, and those in brackets the difference from normal in °F.: Lisbon, 55.7 (+0.7); Zurich, 40.6 (+2.5); Aberdeen, 46.5 (+4.0); Stockholm, 38.8 (+4.6); Haparanda, 32.6 (+9.7); Vardo, 33.9 (+5.7). In Lapland the excess above the normal amounted to 13°F. Still more remarkable were conditions over Spitsbergen, where the average temperature of 29.4°F. was no less than 20.2°F. above normal. As will be seen from fig. 1, Spitsbergen lay just to the north of a region of very strong southerly or south-westerly winds. The normal pressure difference between Vardo in the north of Norway and Stykkisholm in the north of Iceland in November is only 3.9 mb., but this year the difference amounted to 32 mb. Similar conditions prevailed to a lesser extent over the whole of western Europe, which was flooded with warm air from the sub-tropical Atlantic.

In the interior of Europe rainfall was generally below normal, the deficit being 1.4 in. at Zurich. In Sweden rainfall was only about half the normal in Gothaland and eastern Svealand, and was somewhat below normal elsewhere, except in north-eastern Norrland, where the winds blowing off the Baltic gave an excess of rain. At Vardo in northern Norway on the other hand, the rainfall amounted to only about 0.6 in. compared with a normal of 2.4 in.

Weather conditions in the United States appear to have been as abnormal as those in the British Isles. Mr. Earl C. Austin, of Auburn, Maine, writes that a cold spell continued from November 6th to 9th, during which the thermometer at Auburn fell to 19°F. on the 8th. A few warm days followed, the maximum on the 10th being 74°, which is the highest November maximum on record at Auburn. The middle of the month was again cold, the maximum on the 15th being only 38°, while on the morning of the 16th the ground was covered by four inches of

snow. The weather contrasts continued, and on the 21st another period of extraordinarily warm weather began, the maxima being 64° on the 21st, 72° on the 22nd, and 68° on the 24th. A temperature of 76° was recorded at Cincinnati on the 22nd, and one of 77° at Boston on the 23rd. The whole of the eastern and middle western States enjoyed summer-like weather, while at the same time the far west experienced very low temperatures and blizzards. This remarkable distribution was caused by the abnormal intensity and westward displacement of the Atlantic anticyclone, shown by the excess of pressure north of Bermuda in fig. 1. Pressure was abnormally high over the eastern States, and abnormally low over the Mississippi Valley, Plains States and the region of the Great Lakes. This distribution, characteristic of summer, was associated with steady southerly winds and a flood of warm air from the Gulf of Mexico over the eastern half of the country. The average temperature for the whole month was probably well above normal in the eastern States.

Over Oregon and the plateau region there was a large anticyclone, which gave cold northerly winds in the far west, and on November 22nd the United States Press reported an unofficial reading of -40°F . near Helena. On the 25th this anticyclone began to advance eastward and a cold wave spread over the whole country, the maximum temperature in Auburn on the 26th being only 32°F . Precipitation was generally light in the east, but above normal in the middle west, where several rivers in Kansas, Oklahoma, Missouri and Iowa reached the flood stage.

Among numerous letters received about the rainfall of November 2nd and 3rd were the following:—

At 9 a.m. yesterday morning the 4th, I measured 3.72 in. of rain for the preceding 24 hours—it fell in 21 hours.

I have kept a record of rainfall for 38 years—nine at this station—and yesterday's fall was the largest I have ever recorded. The nearest approach was 3.63 in. on October 6th, 1929.

H. K. G. ROGERS.

Seaforde, Mary Tavy, Nr. Tavistock, S. Devon. November 5th, 1931.

On November 4th we experienced the worst flood within living memory. Following upon extremely heavy continuous rain all through the 3rd the river Usk reached an amazing height on the morning of the 4th at 8 a.m. The valley was a huge sheet of water. At Crickhowell the people in some of the houses were forced to take refuge in upper rooms. My rain-gauge gave 4.34 inches in the 24 hours—a record for this station.

It was phenomenally warm, the screen maximum being 59.1°F . and minimum 54.7°F ., grass minimum 50.0°F . The

wind, which was south, reached 40 m.p.h. in gusts, veering to west on the morning of the 4th, when the rain luckily ceased.

One of our farmers lost 83 sheep. Much damage to walls, fences, &c., and on every hand is evidence of the absolutely record-breaking height reached by the flood.

R. G. SANDEMAN.

Dan-y-Parc, Crickhowell, Breconshire, South Wales. November 5th, 1931.

The Influence of the Moon on the Weather

By LIEUT.-COMDR. C. P. SATOW, R.N.

As an amateur, the fact that the belief in the influence of the moon was so very widespread among practical men whose living is dependent on weather conditions led me to think that, possibly, the failure in the past to connect the two was due to investigators not having sufficient data at their disposal, and that to-day, with the far better methods of recording and fuller records, some link might be found.

With this in view I started to analyse the Isopleth Diagrams given on the back of the *Monthly Supplement to the Daily Weather Report*.

I had first to get some figure which I could note down and which would bear a definite relation to the weather on the day in question. I therefore counted the number of lines of the diagram in each section of 24 hours, thus giving one a rough figure for the disturbance of the air on the line for which the diagram was constructed. If the figure was a high one the air was much disturbed, if low then the air was still. These figures

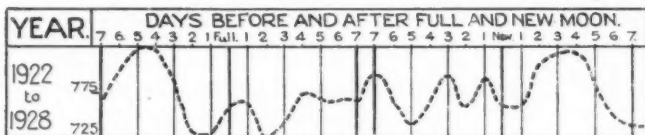


Fig. 1.—TOTALS OF ISOPLETH COUNT FOR THE YEARS 1922-8.

I arranged in accordance with Full and New Moon, allowing a fifteen-day interval between full and new. Of course, this was not always the case, but on occasions when the interval was shorter I repeated the figure for seven days after full and used it for seven days before new, and if the interval was longer I discarded the extra day in the middle. The arrangement gave twelve sets of similarly disposed figures for any one year. The results of seven consecutive years were added together and plotted, the resulting curve being shown in fig. 1.

It will be seen that the curve is decidedly erratic, though there is a tendency for the weather to improve after full moon and to be worse after new. This tendency I had noticed to be most marked in the autumn months, so I divided the year into four

parts, three months to each, and then plotted the sums of the last periods, which roughly covered October, November and December. The result is shown on the broken curve in fig. 2.

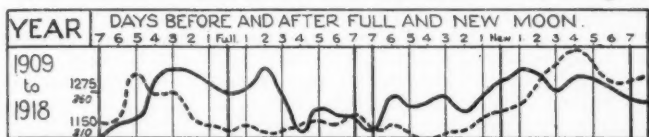


Fig. 2.—TOTALS OF ISOPLETH COUNT FOR OCT., NOV., DEC., 1921-8. TOTALS OF WIND FORCE AT LERWICK, SPURN HEAD, CASTLEBAY, VALENTIA, SCHILLY AND LONDON, FOR OCT., NOV., DEC., 1909-18.

The tendency is most marked and the variation between maximum and minimum is proportionately greater. The results for the other three quarters of the year were erratic and showed no indications of any connexion with the lunar period.

The next step was to see if the result obtained for 1921 to 1928 persisted in other years, but here a difficulty occurred as 1921 was the first year that isopleth diagrams were published.

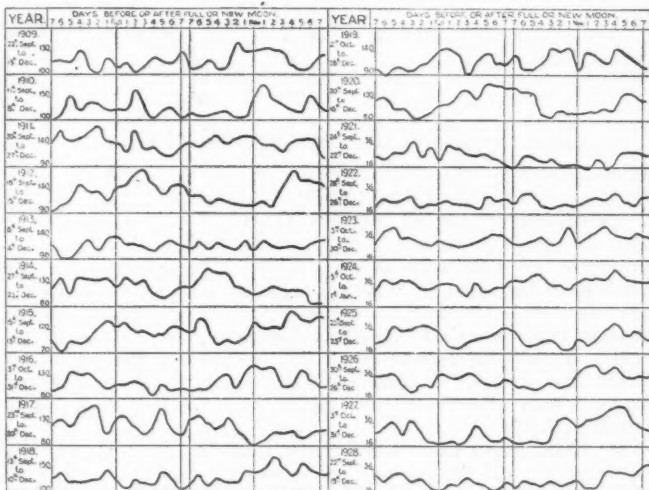


Fig. 3.—1909-20. TOTALS OF WIND AT LERWICK, SPURN HEAD, CASTLEBAY, VALENTIA AND LONDON. 1921-8. TOTALS OF ISOPLETH COUNTS.

To overcome this I tried plotting the sum of wind forces at a few selected stations scattered over the British Isles, and the resultant curve followed the curve obtained from the isopleth count almost exactly. Treating these wind force totals in the

same way as I had the isopleth numbers, the full curve, shown in fig. 2, was obtained for the years 1909 to 1918, but it will be seen that the tendency previously noticed is not nearly so pronounced. Moreover, the range between maximum and minimum is not so great. The plotting of individual years brings out some interesting points. In fig. 3 it will be seen that the years 1909, 1918 and 1927 bear a decided resemblance to one another. It is in the autumn of these years that Perigee coincides with full moon; 1913 and 1922 also are rather similar, and in these years Perigee coincides with the new moon.

Of course, taking the last three months of the year, since the weather is generally getting more stormy the curves would normally tend to rise slightly from left to right. But, taking the isopleth count figures the average rise would only be 2.2, and this figure was so small that it was not considered to be worth while to attempt to correct the curves for the normal annual effect of the sun.

Whilst it cannot be claimed that the figures shown in the diagrams consistently support the hypothesis that the movements of the moon are related to the weather conditions in the British Isles, it is felt that they are suggestive and that a more detailed examination of the years which show signs of similarity should prove interesting and may produce something of value.

Discussions at the Meteorological Office

November 16th, 1931.—*Historical note on the catch of rain-gauges.* By H. R. Puri (India Meteor. Dept., Sci. Notes, Calcutta III, No. 23, 1931). *Opener*—Dr. J. Glasspoole.

The necessary preliminary to any useful investigation is a survey of our knowledge of the subject. The literature on the catch of rain-gauges is extensive, and the task of summarising must have been arduous. The present paper is a useful supplement to that published in *British Rainfall*, 1900, by Dr. H. R. Mill. It will be recalled that Dr. Mill wrote the paper on "The Development of Rainfall Measurement in the last Forty Years," soon after he became Director of the British Rainfall Organization.

Mr. Puri treats the subject under three main heads: (1) the instruments; (2) the methods of correcting over-exposure; and (3) under-exposure.

In the consideration of the instruments for measuring rainfall the advantage of the standard gauge with the deep Snowdon funnel, over the older pattern with the shallow funnel, is not mentioned. The advantage of the deep funnel gauge is that it gives a better sample of the precipitation during heavy rain or

hail, and during snow. On the other hand the deeper gauge exposes a larger area, resulting in a slightly greater loss by evaporation. The advantages of the Snowdon funnel gauge far outweigh this small defect.* Attention is, however, directed to the disadvantage of painting the funnel of the gauge. Paint may swell, become spongy and absorb an appreciable amount of rain, in addition to retaining some in its crevices, so that loss by evaporation may result.

It is interesting to note that the diminution in the catch of a rain-gauge as the rim is raised from the ground level, was explained by the increased effect of wind eddies at higher elevations as early as 1821. Details are given of the various protecting devices which have been adopted to correct the catch of the gauge. The most successful devices are the turf wall and the pit. The turf wall used at Holyhead† was 8 ft. in diameter with the crest of the turf wall horizontal and level with the rim of the gauge, which was 1 ft. above the ground inside the wall and 8 inches above the ground outside. The pit used at Valentia Observatory‡ was 5 ft. square, with vertical sides 1 ft. deep. The gauge was placed in the centre of the pit with the rim level with that of the ground outside.

Since the paper was written the experiments by Mr. F. Hudleston at Hutton John, near Penrith, have been continued. Although the results are summarised in the annual volumes of *British Rainfall*, they are of such outstanding interest that some reference to the conclusions seems warranted. It is shown that the exposure of the gauge in the direction of the prevailing wind is of fundamental importance; that shelter in that direction by gently rising ground or by a wood at a distance from the gauge of about twice the height of the trees results in a reasonable catch; that in a badly over-exposed site on ground sloping down about 1 in 8 in the direction of the prevailing wind the loss due to over-exposure is materially reduced by the use of a turf wall. The turf wall used is 10 ft. in diameter, with the gauge in the centre. It is a few inches thick at the top, the inside wall is vertical, while the outside wall slopes down about 1 in 3. The crest of the turf wall is horizontal and level with the rim of the gauge. The experiments are being continued, and some slight modifications in these details may prove desirable.

The experiments demonstrate that while a turf wall round a gauge in an over-exposed site appreciably reduces the loss, it does not eliminate the error entirely in winds of all strengths. A gauge should wherever possible be set up in a site with suit-

* *Washington, D.C., Monthly Weather Rev.*, 1931, p. 157, Rain-gauge funnels of different depths, by J. Glaspoole.

† See *British Rainfall*, 1926, p. 282.

‡ See *London Q.J.R. Meteor. Soc.*, 52, 1926, p. 67.

able natural shelter, especially in the direction of the prevailing wind, and the turf wall should be used only if such a site cannot be found.

November 30, 1931. *Contribution to the aerology of the Indian monsoon.* By A. Wagner. (Beitr. Geophysik, Leipzig, 30, 1931, pp. 196-238.) (In German.) *Opener*—Mr. S. P. Peters, B.Sc.

This paper consists of three sections dealing respectively with (1) the air circulation in the NE. monsoon, (2) the air circulation in the SW. monsoon, (3) certain aspects of conditions over India during the SW. monsoon. For (1) and (2) the data utilised were pilot balloon observations at 46 stations distributed irregularly over India, Burma, the Persian Gulf, Iraq, Syria and Egypt, the periods covered by the observations varying for different stations and heights from one to 15 years. In particular, it is important to note that for the discussion of the air circulation in the SW. monsoon at heights above 3 Km. the available data are for 20 stations only out of the 46, and in the case of 12 of these stations the observations are for one year only. In treating the NE. monsoon the months December-February were combined, and for the SW. monsoon, June-August, and the main feature of the paper is a series of charts for the two monsoons showing mean lines of flow of air at different heights, without reference to speed.

For the NE. monsoon the author confines his attention to the heights 0.5, 1, 2, and 3 Km. At each of these heights he indicates a surface of separation between an air stream approaching northern India from west or north-west, and the NE. monsoon, this boundary surface being shown at the first two heights as running approximately north to south a little distance to west of the Indus, whilst at 2 and 3 Km. it lies west to east across India between latitudes 15° and 20° N. An examination of the individual resultant wind vectors on which the charts are based (which are given in tables at the end of the paper) does not, however, in itself afford convincing evidence of the existence of fronts so definite in character and position as to justify the boldness with which they are indicated on the charts. Even if one admits the existence of a pronounced boundary surface between the westerly current from Iraq and Arabia and the NE. monsoon, the position assigned to it by Wagner at 0.5 and 1 Km. is open to criticism; but, as was pointed out in the discussion, there is a not uncommon tendency amongst meteorologists to assume the existence of a front on the basis of only slender evidence, and in this particular case an examination of at least the individual pilot balloon observations, or a representative selection of them, is a necessity before the reality of the discontinuity as a permanent feature of the NE. monsoon can be assumed.

In the case of the SW. monsoon, which is considered up to a height of 10 Km., the author indicates up to 5 Km. a surface of separation between a dry continental air stream and the moist monsoon current, and although there are more *prima facie* reasons for accepting the existence of this front than there are in the case of the NE. monsoon, there are again definite objections to be raised against the appearance of finality with which the positions assigned to it on the charts at the various heights up to 5 Km. seem to be invested. In this case the objections rest not only on the basis of the lack of consideration of the results of individual ascents, but also on account of the weighted character of pilot balloon observations, which arises on account of varying cloud amount during different states of development of the monsoon. Cloud is less prevalent, and hence pilot balloon observations are more frequent, during periods of "feeble monsoon" or of "breaks in the monsoon" than during "active monsoon" conditions, and consequently any deductions as to air circulation based only on pilot balloon data are by no means representative of average conditions throughout the SW. monsoon season. Also, for heights above 3 Km., for which, as already pointed out, there are very limited data available both in space and time, the detailed features of the charts cannot be regarded as more than approximations to true average conditions. Actually, on account of the alternations from activity to inactivity which the SW. monsoon current exhibits, and the associated changes in the air circulation which must accompany these alternations, the precise significance and value of charts purporting to show mean conditions of air flow during the SW. monsoon season are open to question, and the value of the results presented in Wagner's paper is better appreciated when it is realised that they refer mainly to inactive monsoon conditions.

Royal Meteorological Society

The opening meeting of this Society for the present session was held on Wednesday, November 18th, at 49, Cromwell Road, South Kensington. Mr. R. G. K. Lempfort, C.B.E., M.A., President, in the Chair.

J. Edmund Clark, Ivan D. Margary, Richard Marshall, C. J. P. Cave, and L. C. W. Bonacina.—*Report on the Phenological Observations in the British Isles, from December, 1929, to November, 1930.*

The year 1930 was officially characterised as "A Wet Year." Abnormal December and January warmth and excess of sunshine in December, 1929, and November, 1930, make very partial amends for almost continuous adverse conditions in between, save only in June and the brief spell of glorious harvest weather

which ended August. Hence, for farm and garden, conditions were as a rule bad. The result on the floral calendar was that no district records were early before the convolvulus in July. Spring flowers in southern parts were almost a week late. But the floral isophenes were naturally much nearer normal than in 1929. The corresponding isakairs (lines of equal difference from normal flowering date) were early mainly over southern Scotland and north-west Ireland; they were latest in west Ireland, central Highlands and scattered English areas. Insects and birds were late; the 20 migrants by two days. A natural exception was the very early first song of the thrush. The spring isophenes can now be compared with the chart of return movements, a matter of decided interest.

Sir G. T. Walker, C.S.I., F.R.S., and A. C. Phillips.—The forms of stratified clouds: Part 1, experimental. Part 2, discussion.

In continuation of experimental work on vertically unstable liquids by E. H. Weber, Bérnard, Idrac and Mal, an examination was made of the patterns set up in a heated liquid moving along a rectangular trough. As this did not produce vortices with their axes at right angles to the flow, recourse was had to unstable air flowing along a small wind-channel, the motion being indicated by fumes of titanium tetrachloride. By suitable increases of velocity, from zero, the patterns produced were polygons, transverse vortices, crossed vortices, and longitudinal vortices, and the resemblance to clouds was more obvious than when liquids were used; it must, however, be remembered that the shear changes sign; also, the motion inside the cells was downward, not upward as with liquids. Downward motion in clouds is at times conspicuous half-way up in the wind-channel, but not in cloud stratum.

William Dunbar.—Eighty years' rainfall at North Craig Reservoir, Kilmarnock.

The paper deals with the rainfall records kept at North Craig Reservoir for the past 80 years. Table I gives the yearly totals for the period together with the percentages of these figures to the long average. On this table are also shown the ten driest and ten wettest years. All but one of the driest years occurred during the first 40 years, while the majority of the wet years occurred in the second half of the 80-year period. The table is also divided into decades and brings out the fact which the complete analysis confirms—that the first 40 years of the period were drier than the second 40—only one decade (1861-70) in the first period exceeds the average, while only one (1911-20) in the second half is under the average. The author compares the North Craig figures with those of a gauge in the east of Scotland, and with the average for Scotland, the figures suggest

that the west is becoming wetter and the east drier. The analysis of the data of each month, quarter, half-year and seasonal year is fully dealt with giving highest and lowest falls for the period, the highest and lowest for each month, etc., and in these figures the fact of the dryness of the first 40 years is again brought out.

Correspondence

To the Editor, *The Meteorological Magazine*.

Bush Fires and Whirlwinds

The observations of whirlwinds starting from the fire-front of bush fires, given in Mr. Wilson's note,* are of great interest.

The motion of the whirlwinds appears to me to be that which would be anticipated if they were clockwise whirls, the curvature of the path arising from the effect of friction; the curvature of the path would be opposite in anti-clockwise whirls. A clockwise whirl would be a "cyclonic" whirl in Southern Rhodesia.

The great difference of temperature between the fire-front and the air to windward of it (and, to a lesser extent, the air to leeward) would be sufficient to originate the whirls; but I do not think one would have expected them all to have the same direction of rotation. If they do, it is even more surprising than the results for sand-devils recently published by Captain Durward.†

E. GOLD.

Alto-cumulus castellatus and mammato-cumulus clouds

Mr. Petrocokino in his letter published in your September number remarks that he has never seen a mammillated hybrid cirrus sheet with a severe thunderstorm.

On June 6th, 1931, during a heavy thunderstorm, which I believe did considerable damage, a mammillated sheet of false cirrus or alto-stratus was observed at Brundall, Norfolk, at 19h. 45m. G.M.T. The storm was due to surface heating of maritime polar air, which had curved round a large depression west of Ireland and had a long land track over southern England. Heavy and minor storms had occurred in the afternoon and early evening. The centre of the storm passed south of Brundall, and it was thus possible to observe the upper sky to some extent. The mammillated appearance of the "anvil" was sufficiently striking for a record of its occurrence to be made.

A form of mammato-cumulus has often been observed to occur in an atmosphere with a steep lapse rate of temperature in the lowest layers, but with an inversion of temperature higher up.

**London Meteorological Magazine*, 66, 1931, p. 236.

†*Nature*, London, 128, 1931, pp. 412-13.

Cumuli develop due to surface heating, but spread out higher up under the inversion, frequently forming a continuous sheet of cloud which often has a mammillated appearance. Perhaps this is the same as Type I mentioned by Mr. Petrocokino. This form of mammato-cumulus is thus formed in what is usually a stable atmosphere and is not associated with any particular phenomenon. The inversion is usually too low for even slight showers to develop.

L. DODS.

School of Artillery, Larkhill, Salisbury Plain. November 5th, 1931.

Fog Bow

Mr. Thomas M. Prosser, Meteorological Observer at the Royal Agricultural College, Cirencester, observed a fog bow at 9 a.m. on November 21st. His description is as follows:—"There was a fairly dense wet fog present (visibility 220 yds.). The fog appeared to be clearing, however, in the upper air, as the sun was just beginning to penetrate through. At about 110 yds. from the observation ground to the north-west there appeared a perfect white arc, and I should imagine the arc was about 80 feet high at the apex, and approximately 200 yds. in length from end to end. As the fog cleared so the arc faded away, until at 9.15 it had disappeared entirely."

The fog bow is a white rainbow seen opposite the sun in fog. It is produced in the same way as the ordinary rainbow, but owing to the smallness of the drops the colours overlap and the bow appears white.

Loss of Human Life in Blizzards in Cornwall

Dr. J. Hambley Rowe, of Bradford, President of the Royal Cornwall Polytechnic Society, has called my attention to his having found among the Registers of Burial of the parishes of Phillack, Breage and Paul, all in west Cornwall, nine burials of persons who died in the snow in December, 1630. . . . It would be interesting to learn whether there are any other records of this great fall of snow or of any other human lives being, as the Paul register expresses it, "drowned" in the snow at any other time in Cornwall. Dr. Rowe has examined a great number of Cornish parish registers, but in no other case has he come across deaths in the snow.

WILSON LLOYD FOX.

Carmino, Falmouth. August 15th, 1931.

Destruction of Forests by Peat Moss

Reading "Past and Present" for the first time in forty years, and, by odd coincidence, immediately after Dr. Brooks's

most interesting lecture on " Climatic Changes since the Ice Age " (Vict. Inst., May 18th), I came on Carlyle's explanation of the loss of the forests, which may be of sufficient interest to publish. Quoting from *Jocelini Chronica*, p. 21, where it is said that Abbot Samson with his monks " would sit in some opening of the woods, and see the dogs run; but he himself never meddled with hunting, that I saw " (time, about 1200 A.D.; place, St. Edmundsbury), Carlyle goes on to say: " ' In an opening of the woods; ' for the country was still dark with wood in those days; and Scotland itself still rustled shaggy and leafy, like a damp black American forest, with cleared spots and spaces here and there. Dryasdust advances several absurd hypotheses as to the insensible but almost total disappearance of these woods; the thick wreck of which now lies as peat, sometimes with huge heart-of-oak timber-logs imbedded in it, on many a height and hollow. The simplest reason doubtless is, that by increase of husbandry, there was increase of cattle; increase of hunger for green spring food; and so, more and more, the new seedlings got eaten out in April; and the old trees, having only a certain length of life in them, died gradually, no man heeding it, and disappeared into peat. A sorrowful waste of noble wood and umbrage! Yes, but a very common one; the course of most things in this world."

There may be something in it as regards destruction of the forests in the " recent period," though it leaves the formation of the peat itself unexplained; but on one point we can be quite clear, viz., that, if the distinguished author of " Past and Present " had been present to have heard Dr. Brooks's paper read, he would have withdrawn the term " Dryasdust," repenting in sackcloth and ashes.

T. C. SKINNER.

8, Smoke Lane, Reigate, Surrey. May 23rd, 1931.

NOTES AND QUERIES

Abnormal Behaviour of Pressure-Tube Anemograph

We do not know if the effects to be described have been noticed before by observers in charge of pressure-tube anemographs, but as we have not seen any mention in print it seems worth while calling attention to them.

When all adjustments are made to the Dines pressure-tube recorder (M.O. 1065/30) in operation at Worthy Down, *i.e.*, water-level correct and shot adjusted so that the scratch on the pen rod is coincident with the top of the brass collar, and when both pressure and suction taps are turned off, the " floating zero " is nearly 3mm. above the zero mark which can be obtained by depressing the float rod by hand until the float touches the bottom of the water container. Normally, when the wind falls

to a dead calm (both taps being on), the velocity pen falls to the correct "floating zero," but on certain occasions the charts show that it has fallen below the zero line; ; that is to say, the record shows a negative velocity of 1 or 2 m.p.h.

The effect has been most marked between 5h. and 9h. G.M.T. on the following days:—

April 12th, 1931 (see fig. 1)	July 29th 1931.
" 30th, "	Sept. 8th, "
May 31st, "	" 9th, "
July 9th, " (see fig. 1)	" 29th, "

On each occasion the sun had risen shortly before, and the weather was quiet with little or no cloud after a cold night.

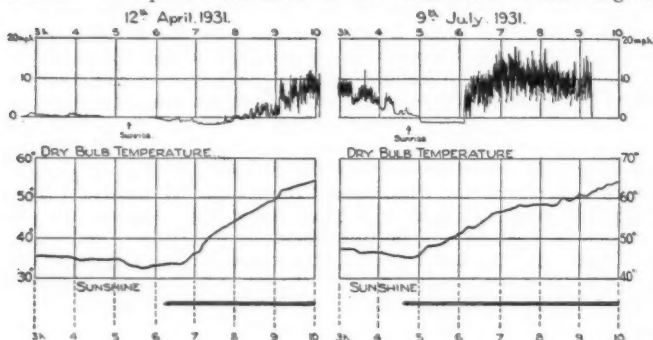


FIG. 1.

The explanation seems to be that a rapid rise in temperature of the iron piping between the vane and the roof of the hut (a distance of 27 feet) is communicated gradually to the air inside the tubes resulting in a diminution of pressure in both pipes. This rarefaction in the pressure tube produces a greater effect in the recorder than that in the suction tube; at midsummer at Worthy Down this is enhanced by the fact that the pressure tube becomes heated more strongly because the mast itself protects the suction tube from the rays of the rising sun. The tubes are 1 inch in diameter and painted black.

The following tests were carried out between 7h. 52m. and 8h. 15m. G.M.T. on September 9th. The sky was cloudless and a very low wind speed of 30 ft./min. ($1\frac{1}{3}$ m.p.h.) from NNW. was recorded by an airmeter which was tied to the top of the vane. The temperature of the outside of the pressure piping was approximately 60° - 62° F. at the time of the test, whilst the screen minimum had fallen to 38° F. two hours previously.

With both taps turned either on or off the pen recorded to all intents and purposes a zero wind. When the pressure tap only was turned on, the pen fell almost instantaneously, and the fall

was only arrested by the float touching bottom. When the suction tap only was turned on, the pen rose sharply to 3 m.p.h. A little shot was then removed from the cup to bring the pen to the 5 m.p.h. line on the chart with both taps off. With the suction tap only turned on, the pen rose 2 m.p.h., and with the pressure tap only turned on, it fell 3 m.p.h. Similar results were obtained when the vane was taken off.

In order to find out to what extent vertical air currents produced by the warmed corrugated iron roof of the building in which the recorder is housed might be responsible for the suction effects observed in both tubes, the airmeter was then suspended from the vane with its axis vertical. A rising current of 28 ft./min. (approximately $1/3$ m.p.h.) only was registered over a five-minute interval.

It has been noted frequently that when the pipes are subjected to bright sunshine with a wind of as much as 6 m.p.h., turning off the pressure tap makes no appreciable difference to the recorded mean wind speed—it may even increase it if there is hot sunshine. When cloud appears, however, and the sun's rays are cut off, the suction:pressure ratio assumes its normal value.

It would appear therefore that—

(1) when a "bad zero" is shown on a pressure-tube anemogram it may not mean that the instrument is out of adjustment;

(2) the accuracy of measurement of low wind speeds is impaired under certain conditions, especially if one pipe is exposed to bright sunshine whilst the other is in shadow;

(3) the testing of an anemometer by noting the behaviour of the velocity pen when the pressure and suction taps are turned off and on is best done on a cloudy day. On a bright morning with a light wind, the fact that the pen fails to respond properly when the pressure tap is turned on is by no means a sure indication that there is a fault in the pipe or the recording mechanism.

C. V. OCKENDEN,

C. F. J. JESTICO.

R.A.F. Station, Worthy Down, Winchester. October 20th, 1931.

The point raised in the above letter is of considerable interest. There is no doubt that if a pressure-tube anemometer is tested in a light wind by turning on the pressure and suction taps alternately, and at the same time the vertical connecting pipes are strongly heated by sunshine, the resulting movement of the pen is somewhat disconcerting. This is due, as is pointed out, to the fact that the heated air in the pipes is of different density to that of the surrounding atmosphere. Thus, if there were no wind blowing so that the pressure inside the pressure and suction tubes at the head were identical with that outside the head at the same level, there would be a difference of pressure at the

recorder between the room and the inside of either of these pipes, the room pressure being the higher. Assuming that both pressure and suction pipes are at the same temperature, the effect will be the same in both and there will be no error in the records of the instrument in normal working. Although this statement appears at first sight to be contradicted by a statement in Mr. Ockenden's and Mr. Jestico's note, that when the suction tap only was turned on the pen rose from 5 to 7 m.p.h., while with the pressure tap only turned on it fell from 5 to 2 m.p.h., this experiment actually shows that the pressure effect in the two pipes was closely similar, the change of pressure required to move the pen from 5 to 7 m.p.h. being practically the same as that required to move the pen from 2 to 5 m.p.h. An error will, therefore, only be introduced into the records if the pressure and suction pipes are heated differently. This may happen, as pointed out, if the sun is shining and one pipe is in the shadow of the mast, while the other is exposed to the full sunshine. It is easy to calculate the effect which may occur in this case. Assuming that 30 feet are exposed to sunshine and that the difference of temperature is 20°F . (probably a somewhat extreme figure), the pressure difference at the bottom introduced by this differential temperature effect will be 47mm. of water. If there is no wind blowing the instrument will record 5 m.p.h. if the suction tube is the one heated. The error rapidly falls with increasing velocity, being $1\frac{1}{2}$ m.p.h. at 10 m.p.h., and only $\frac{1}{2}$ m.p.h. at 20 m.p.h. Fortunately, strong differential heating of this kind will only occur in this country with the sun fairly high in the heavens and calms during the daytime are of much less frequent occurrence than during the night so that the full error of 5 m.p.h. will seldom occur.

It would be of interest if observers, in charge of anemometers, so arranged that the suction pipe was exposed to sunshine for a few hours after sunrise in the summer, while the pressure pipe was shielded, would study their records to see whether there was any indication of a fictitious rise of wind due to the heated suction pipe. Such a fictitious wind would, presumably, be free from gusts.

With regard to the anemometer at Worthy Down in which the pen is able to fall 3mm. below the zero position, this degree of latitude is unusual. As a rule the zero mark on the pen rod almost coincides with the position of rest of the float on the bottom of the tank. The control of the pen movement given by the buoyancy of the shaped part of the float ceases when the pen reaches the zero mark, so that movements of the float below this point are practically uncontrolled and have little meaning.

It may be of interest to mention that the effect of heating the pressure and suction pipes of anemometers was first noticed by me many years ago when working on the pressure-tube anemo-

graph at the Upper Air Station at Pyrton Hill. At this time I designed a head in which the pressure and suction were brought down in two concentric tubes, the outer one of which formed the anemometer mast. One advantage of this design was that the inner pipe naturally took up the same temperature as that of the outer one so that errors in the record due to differences of heating in the two pipes were eliminated. Practical difficulties were, however, found in this design which prevented its coming into general use.

J. S. DINES.

The Vertical Temperature Gradient in the Arctic

A recent publication of the Administration of Hydrography, Leningrad, Hydro-meteorological section,* gives the results of 44 kite ascents in 1914 and 1915 between latitudes 73° and 78° N., longitudes 80° and 105° E. The tables give for various heights, in steps of a few hundred metres, the temperature, relative humidity, wind direction and velocity, remarks and control observations made on board the vessel.

A glance at the tables is sufficient to indicate the usual presence of an inversion of temperature in the lower layers, which is more marked the lower the surface temperature. To bring this out, I prepared the following tables, employing the 34 ascents which exceeded a height of 500 metres. As a rule the

TABLE 1. SEASONAL VARIATION.

Temperature	Winter	Summer	Equinox
	(Nov.-Feb.)	(May-Aug.)	(Mar., Apr., Sept., Oct.)
	$^{\circ}\text{C.}$	$^{\circ}\text{C.}$	$^{\circ}\text{C.}$
Average at 0m.†... ..	-27.5	-1.2	-23.5
Change of temperature—			
0-500m.	+3.7	+0.4	+4.8
500-1000m.	+1.9	-1.2	+1.6
1000-1500m.	—	-0.8	-2.0

TABLE 2. RELATION BETWEEN SURFACE TEMPERATURE AND INVERSION.

	Surface temperature.				
	Below -30° C.	-30 to -20° C.	-20° to 0° C.	Above 0° C.	All readings.
Number of ascents ...	9	7	10	8	34
Average at 0m. ...	-36.7	-23.7	-6.1	+3.0	-15.7
Change of temperature—					
0-500m. ...	+7.6	+4.4	-0.5	+0.7	+3.0
500-1000m. ...	+2.0	+0.3	-1.9	-0.9	+0.2
1000-1500m. ...	—	-2.0	-1.3	-0.2	-1.2

* Observations hydro-météorologiques des expéditions hydrographiques. Matériaux de l'Expédition Hydrographique de l'Océan Glacial du Nord 1910-15. By N. Evgenov. Leningrad 1931. Les résultats des observations aérologiques reçues par des levers de serf-volant sur le navire hydrographique "Taimyr," faites en 1913-15.

data are for each 500-metre level, both ascending and descending; in a few ascents the figure at the exact level had to be interpolated from neighbouring readings. The averages of the ascending and descending readings were taken for each ascent.

It appears that the presence and extent of the inversion of temperature are closely related to the surface temperature. The latter, of course, varies with the season, but no other seasonal effect on the inversion is obviously shown. The correlation coefficient between surface temperature and change of temperature between 0 and 500 m. is -0.69 and the regression equation:—

$$\text{Change of temp. } 0-500\text{m. (}^{\circ}\text{C.)} = -1.0 - 0.24 \times (\text{surface temp.})$$

Thus, on the average, the inversion disappears when the surface temperature rises to -4°C. , but there is some irregularity at the higher temperatures.

The average depth of the inversion is about 1,000 metres in the equinoxes and below 500 metres in summer. None of the winter ascents reached the summit of the inversion, but by extrapolation it would appear to lie at about 1,250 metres.

C. E. P. BROOKS.

REVIEWS

Physics of the Earth—III—Meteorology. Washington, D.C., National Academy of Sciences, National Research Council, Bulletin No. 79, 8vo., pp. xi+289. *Illus.* 1931.

In 1926 a Committee of the National Research Council of the United States of America was appointed to prepare a series of Bulletins on the Physics of the Earth, the purpose being "to give to the reader, presumably a scientist, but not a specialist in the subject, an idea of its present status, together with a forward-looking summary of its outstanding problems." It was realized that geophysics occupied a kind of middle place among the other physical sciences, and that there were lacking systematic treatises in English dealing with its various branches. This volume on meteorology forms one of a series of nine volumes which are intended to cover the field of geophysics. It consists of an introduction, six chapters, and an index, as follows:—

Introduction, 4½ pp. Development of the Science of Meteorology, by H. H. Kimball.

Chap. I, 14 pp. The Atmosphere: Origin and Composition, by W. J. Humphreys.

Chap. II, 19 pp. Meteorological Data and Meteorological Changes, by A. J. Henry.

Chap. III, 31 pp. Solar Radiation and its Role, by H. H. Kimball.

Chap. IV, 65 pp. The Meteorology of the Free Atmosphere, by W. R. Gregg, L. T. Samuels and W. R. Stevens.

Chap. V, 100 pp. Dynamic Meteorology, by H. C. Willett.

Chap. VI, 45 pp. Physical Basis of Weather Forecasting, by R. H. Weightman.

The book consists therefore of a number of essays on meteorological subjects, written by different persons in collaboration. The essays do not cover the whole of the subject (a notable omission being meteorological optics), and the collaboration is not close enough to avoid a certain amount of duplication. The work is consequently not a text-book on meteorology, and perhaps it was not intended to be one.

It can be stated that Mr. Willett's chapter on Dynamic Meteorology is at once the longest and most important chapter in the book; it is also the chapter which will be most attractive to the majority of students of meteorology. It contains a fairly detailed mathematical discussion of the thermodynamics and dynamics of the atmosphere, followed by a purely descriptive account of recent theories on the general circulation of the atmosphere, and on the origin, growth and decay of cyclones and anticyclones. A considerable portion of the mathematical part might well have been omitted, as being otherwise available in English, and the space re-allotted to an expansion of the descriptive part at the end, which has been written in an interesting and thoughtful way, and should be of considerable use to English readers. This author succeeds well in giving "a forward-looking summary of outstanding problems."

Turning to the other chapters, Prof. Humphreys writes in his usual interesting manner on the origin and composition of the atmosphere; he does not fail to introduce to his readers the relations which have recently been found between ozone and meteorological phenomena.

Prof. Henry describes very briefly the nature of the meteorological record from geological times to the present day. He refers to the information derived from tree trunks, discusses the Brückner cycle, and passes on to modern instrumental records, which are set out in a form suitable for statistical treatment.

The chapters on Solar Radiation, and on the Meteorology of the Free Atmosphere contain, in the main, careful summaries of instrumental methods and of results of observation.

The last chapter on the Physical Basis of Weather Forecasting is for the most part a description of the methods of weather forecasting used in the United States Weather Bureau, and of methods of long-distance forecasting with the aid of correlation coefficients.

Throughout the book references have been made to the most important recent papers which have been published throughout the world, and at the end of each chapter these papers are listed. This is a valuable feature of the work.

The authors and publishers have done good service by the production of this volume for the benefit of English-speaking peoples.

R. CORLESS.

- Indian Meteorological Department. Scientific Notes.* Vol. II. Nos. 13-14, pp. 21-36. *Illus.* Calcutta, 1930, 1s. 6d. and 8d. net.
- Indian Meteorological Department. Memoirs.* Vol. XXV. Part V. pp. 163-193 (with 6 additional pages of plates). Calcutta, 1930, 3s. 6d. net.
- The Indian Journal of Physics.* Vol. IV, Part VI. pp. 477-502. *Illus.* Calcutta University Press, 1930.

These four papers afford pleasing evidence of the continuance of fruitful activity in India about meteorology.

In the first, Dr. K. R. Ramanathan discusses, under the title of "Atmospheric Instability at Agra associated with a Western Disturbance," the results obtained by observations on eight pilot balloons sent up in succession at Agra on March 30th, 1928, within a period of, approximately, half an hour in the early afternoon. The tail method was employed in each of the ascents; and the surface pressure distribution prevailing was that of a feeble depression. Ascending and descending currents of considerable magnitude were found to exist in addition to considerable fluctuations in the horizontal winds at various heights. Marked peculiarities noted in the distribution of the up and down currents are explained as due to the interposition of a layer of abnormally warm air between two layers of potentially colder air, while the fluctuations in the horizontal winds are deemed to be largely independent either of the strength or direction of the wind, or of the height.

In the second paper, Barkat Ali sets out, under the title of "Horizontal Atmospheric Visibility at Agra," certain empirical relationships found between the horizontal visibility at Agra and other meteorological elements, such as wind direction and force, relative humidity, and the like. The paper follows the lines made familiar to English meteorologists by similar investigations relating to places in the British Isles during the last decade, and is a useful addition to the literature of what may be termed local visibility. It is interesting to record that the results obtained at this inland station in India do not, where they are comparable, differ greatly from those obtained, say, for Cranwell, in England; especially is this similarity noticeable in regard to the relationship between horizontal visibility and wind force.

The third paper, "Discussion of Results of Sounding Balloon Ascents at Agra during the Period July, 1925, to March, 1928, and some Allied Questions," by Dr. K. R. Ramanathan, is a sequel to a well-known paper by Dr. W. A. Harwood,* in which similar observations during the period 1915-8 were discussed. Certain discrepancies from Dr. Harwood's results are noted and

* *Indian Meteorological Dept., Memoirs*, Vol. xxiv, Part vi. The free atmosphere in India, Observations with kites and sounding balloons up to 1918.

examined. Dr. Ramanathan's paper is a storehouse of valuable tables and of diagrams, and deserves to be noted by every serious student of the upper air.

Dr. Banerji, in the fourth paper, "The Effect of the Indian Mountain Ranges on the Configuration of the Isobars," gives an analysis of the part played by the mountain ranges of India in shaping the stream lines in the air during a steady south-west monsoon, and concludes that the peculiarities exhibited by the mean sea-level isobars during typical months of the south-west monsoon as seen in the maps taken from Eliot's "Climatological Atlas of India" are due in very large measure to the mountain barriers. Dr. Banerji reasons closely, and certainly puts new wine into the old bottles of the maps of mean monthly pressures. He has made a contribution to the literature of the monsoons that is to be welcomed.

WILLIAM H. PICK.

Books Received

Enregistrements de l'ultrarayonnement cosmique à Muottas-Muraigl. By F. Lindholm. (Reprinted from Arc. Sci. Phys. Geneva, 5th period, vol. II, pp. 271-2.)

Obituary

Professor Robert de Courcy Ward.—We regret to announce the sudden death on November 12th of R. de C. Ward, Professor of Climatology at Harvard University. Professor Ward was born at Boston on November 29th, 1867; he was educated at Harvard, and after his graduation in 1889 he was appointed Assistant in climatology. He became Instructor in 1895, Assistant Professor in 1900, and Professor in 1910.

Ward had a facile pen, and his lucid and interesting books and articles have done much to spread an interest in climatology in this country as well as in America. His first book, "Practical Exercises in Elementary Meteorology," appeared in 1899, and includes a good introduction to the climatology of the United States, as well as instructions in the reading of meteorological observations. In 1903 he published a translation into English of the first part of Hann's great "Handbuch der Klimatologie," and this translation of a standard work has been widely read in Great Britain as well as in North America. In 1908 Ward published his well-known book on "Climate, considered especially in relation to man," a second edition of which appeared in 1918, and in 1925 he issued a comprehensive study of "Climates of the United States."

In addition to these major works, Ward did a great deal to popularise meteorology in America by writing numerous very readable articles, especially on the practical applications of meteorology to every-day life. He always insisted that a

knowledge of meteorology added greatly to the pleasure of travelling, and he himself visited many parts of the world in search of practical experience of the climates which he described. In 1926 he received the Gold Medal of the Travellers Club of Boston.

Professor Ward also took an active part in the administrative side of meteorology, both in Harvard and in the numerous scientific societies of which he was a valued member. He was President of the Association of American Geographers in 1917, and of the American Meteorological Society in 1920 and 1921. He joined the Royal Meteorological Society in 1895, subsequently becoming a Life Fellow, and contributed two important papers to the *Quarterly Journal*. He leaves a wife and two sons.

It is noted with great regret that Mr. James Davidson, Kirkwall, died in Aberdeen on November 23rd as a result of injuries received in a motor accident on November 12th. Mr. Davidson, who was a sub-agent of the National Bank of Scotland, had, since 1926, taken charge of the climatological station at Kirkwall as a voluntary observer. His work was marked by meticulous accuracy, and the station soon came to be regarded as one of the best in the country. In 1928 a new pressure tube anemograph was added by the Office to the equipment at Kirkwall.

A. H. R. GOLDIE.

We regret to learn of the death of Mr. J. T. Williams on November 15th, 1931, at the age of 71. Mr. Williams joined the Meteorological Office in 1881 and worked first in the Instruments Division. He was transferred to the Marine Division in 1885, and served there until his retirement in March, 1925.

News in Brief

The Council of the Royal Meteorological Society has awarded the Symons Gold Medal for 1932 to Professor V. F. K. Bjerknes, of the Physical Institute of the University, Oslo, Norway. The medal is awarded for distinguished work in connexion with meteorological science and will be presented at the annual general meeting on January 20th, 1932.

The Copley Medal has been awarded by the Royal Society to Sir Arthur Schuster, F.R.S., for his distinguished researches in optics and terrestrial magnetism.

We learn that M. Louis Néel has been appointed Director of the Puy de Dôme Observatory in succession to Prof. E. Mathias, who retired on October 1st, 1931.

The Weather of November, 1931

The account of the weather of the month over Europe and the British Isles will be found on page 249.

The distribution of bright sunshine was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	45	+ 2	Liverpool	44	-15
Aberdeen	47	— 8	Ross-on-Wye	63	0
Dublin	70	— 1	Falmouth	90	+14
Birr Castle	69	+ 5	Gorleston	53	— 9
Valentia	50	— 15	Kew	59	+ 7

The special message from Brazil states that the rainfall in the northern and central regions was generally scarce with .04 in. and 0.51 in. below normal respectively and in the southern regions plentiful with 0.87 in. above normal. The coffee, cane and cotton crops were in good condition. Six anticyclones passed across the country. At Rio de Janeiro pressure was 0.2 mb. above normal and temperature 2°F. below normal.

Miscellaneous notes on weather abroad culled from various sources.

As the result of heavy rains small landslips were reported from various mountain districts above the French Riviera and floods occurred near Mandelieu. Torrential rain fell in Corsica on the 14th and 15th. The fine weather in Switzerland which began early in the month came to an end on the 28th, when after heavy rain, snow fell over the country down to the level of Geneva. (*The Times*, November 10th-30th, 1931.)

Severe storms caused loss of life and extensive damage and flooding in the south of Tunisia early in the month. (*The Times*, November 7th, 1931.)

In the eastern United States temperature was mainly below normal early in the month and much above normal later, while in the mountainous regions and along the Pacific coasts the reverse was the case, and in the central States it was mainly above normal all the time. Rainfall was below normal generally for the first half of the month, but later it was in excess except along the Atlantic coasts. (*Washington, D.C., U.S. Dept. Agric. Weekly Weather and Crop Bulletin*.)

A severe snowstorm, beginning on the 21st, swept across the mountainous deserts of western New Mexico and 600 Indians were marooned on the top of the high mesas. A hurricane struck the oil-producing town of Maracaibo, Venezuela, early in the month. No deaths were reported. Many gales were experienced on the North Atlantic. (*The Times*, November 7th-28th, 1931.)

Rainfall, November, 1931—General Distribution

England and Wales	143	} per cent of the average 1881-1915.
Scotland	...	...	143
Ireland	...	...	192
British Isles	...	...	<u>153</u>

Rainfall: November, 1931: England and Wales

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Lond</i>	Camden Square.....	1'99	84	<i>Leics</i>	Belvoir Castle.....	1'89	85
<i>Sur</i>	Reigate, Alvington.....	3'64	117	<i>Rut</i>	Ridlington.....	2'22	96
<i>Kent</i>	Tenterden, Ashenden...	4'55	151	<i>Line</i>	Boston, Skirbeck.....	1'89	94
"	Folkestone, Boro. San...	4'45	...	"	Cranwell Aerodrome...	2'24	120
"	Margate, Cliftonville...	2'72	113	"	Skegness, Marine Gdns	1'58	73
"	Sevenoaks, Speldhurst	3'84	...	"	Louth, Westgate.....	2'79	108
<i>Sus</i>	Patching Farm.....	3'04	85	"	Brigg, Wrawby St.....	2'65	...
"	Brighton, Old Steyne...	4'29	134	<i>Notts</i>	Worksop, Hodsock.....	2'83	144
"	Heathfield, Barklye...	5'86	159	<i>Derby</i>	Derby, L. M. & S. Rly.	2'87	133
<i>Hants</i>	Ventnor, Roy. Nat. Hos.	4'27	133	"	Buxton, Devon Hos...	6'86	147
"	Fordingbridge, Oaklands	5'51	161	<i>Ches</i>	Runcorn, Weston Pt...	4'41	159
"	Ovington Rectory.....	4'79	144	"	Nantwich, Dorfold Hall	5'21	...
"	Sherborne St. John.....	3'40	119	<i>Lancs</i>	Manchester, Whit. Pk.	5'56	205
<i>Berks</i>	Wellington College.....	2'61	102	"	Stonyhurst College...	6'50	144
"	Newbury, Greenham...	3'37	120	"	Southport, Hesketh Pk	6'45	205
<i>Herts</i>	Welwyn Garden City...	2'75	...	"	Lancaster, Strathspey	7'25	...
<i>Bucks</i>	H. Wycombe, Flackwell	3'05	...	<i>Yorks</i>	Wath-upon-Deane.....	3'37	155
<i>Oxf</i>	Oxford, Mag. College...	2'94	133	"	Bradford, Lister Pk...	6'03	206
<i>Nor</i>	Pitsford, Sedgebrook...	2'78	126	"	Oughtershaw Hall.....	8'98	...
"	Oundle.....	1'74	...	"	Wetherby, Ribston H.	4'46	191
<i>Beds</i>	Woburn, Crawley Mill	2'61	117	"	Hull, Pearson Park...	2'79	127
<i>Cam</i>	Cambridge, Bot. Gdns.	1'90	99	"	Holme-on-Spalding...	3'75	...
<i>Essex</i>	Chelmsford, County Lab	1'74	77	"	West Witton, Ivy Ho.	4'35	126
"	Lexden Hill House....	1'69	...	"	Felixkirk, Mt. St. John	4'37	178
<i>Suff</i>	Hawkedon Rectory.....	2'04	90	"	Pickering, Hungate...	3'08	124
"	Haughley House.....	1'66	...	"	Scarborough.....	1'59	64
<i>Norfol</i>	Norwich, Eaton.....	1'87	73	"	Middlesbrough.....	1'87	88
"	Wells, Holkham Hall	1'68	78	"	Baldersdale, Hury Res.	4'28	...
"	Little Dunham.....	2'57	99	<i>Durh</i>	Ushaw College.....	3'09	123
<i>Wilts</i>	Devizes, Highclere.....	4'21	158	<i>Nor</i>	Newcastle, Town Moor	2'16	89
"	Bishops Cannings.....	3'28	115	"	Bellingham, Highgreen	6'06	177
<i>Dor</i>	Evershot, Melbury Ho.	8'20	192	"	Lilburn Tower Gdns...	4'34	129
"	Creech Grange.....	5'02	122	<i>Cumb</i>	Geltsdale.....	4'77	...
"	Shaftesbury, Abbey Ho.	3'65	113	"	Carlisle, Scaleby Hall	5'31	177
<i>Devon</i>	Plymouth, The Hoe...	6'25	171	"	Borrowdale, Seathwaite	23'10	170
"	Polapit Tamar.....	...	...	"	Borrowdale, Rosthwaite	19'10	...
"	Holne, Church Pk. Cott.	15'89	247	"	Keswick, High Hill...	12'66	...
"	Cullompton.....	5'68	165	<i>West</i>	Appleby, Castle Bank...	6'79	204
"	Sidmouth, Sidmount...	5'41	173	<i>Glam</i>	Cardiff, Ely P. Stn...	5'95	143
"	Filleigh, Castle Hill...	6'84	...	"	Treherbert, Tynywaun	18'11	...
"	Barnstaple, N. Dev. Ath	6'00	153	<i>Corn</i>	Carmarthen Friary....	12'70	255
"	Dartm'r, Cranmere Pool	16'70	...	<i>Pemb</i>	Haverfordwest, School	11'55	234
<i>Corn</i>	Redruth, Trewirgie...	10'79	221	<i>Card</i>	Aberystwyth.....	7'02	...
"	Penzance, Morrab Gdn.	8'31	182	"	Cardigan, County Sch.	10'63	...
"	St. Austell, Trevarna...	8'72	177	<i>Brec</i>	Crickhowell, Talymaes	12'00	...
<i>Soms</i>	Chewtown Mendip.....	4'65	109	<i>Rad</i>	Birm W. W. Tyrmynydd	11'89	178
"	Long Ashton.....	4'69	148	<i>Mont</i>	Lake Vyrnwy.....	10'30	185
"	Street, Millfield.....	3'63	132	<i>Denb</i>	Llangynbafal.....	4'90	159
<i>Glos</i>	Cirencester, Gwynfa...	4'41	148	<i>Mer</i>	Dolgelly, Bryntirion...	10'59	171
<i>Here</i>	Ross, Wichelea.....	5'29	209	<i>Carn</i>	Llandudno.....	3'81	123
"	Ledbury, Underdown...	3'98	163	"	Snowdon, L. Llydaw	9'30	50
<i>Salop</i>	Church Stretton.....	6'39	217	<i>Ang</i>	Holyhead, Salt Island	6'14	148
"	Shifnal, Hatton Grange	3'69	154	"	Lligwy.....	7'03	186
<i>Worc</i>	Ombersley, Holt Lock	3'41	149	<i>Isle of Man</i>			
"	Blockley.....	4'20	...	"	Douglas, Boro' Cem...	11'08	235
<i>War</i>	Birmingham, Edgbaston	3'76	116	<i>Guernsey</i>			
<i>Leics</i>	Thornton Reservoir....	2'39	106	"	St. Peter P't. Grange Rd.	4'61	122

Rainfall: November, 1931: Scotland and Ireland

Co.	STATION	In.	Per- cent of Av.	Co.	STATION	In.	Per- cent of Av.
<i>Wigt.</i>	Pt. William, Monreith	8.77	203	<i>Suth.</i>	Melvich	1.61	...
85	" New Luce School	9.32	182	"	Loch More, Achfary	3.83	45
96	<i>Kirk.</i> Carsphairn, Shiel	17.44	221	<i>Caith.</i>	Wick	2.64	84
94	<i>Dumf.</i> Dumfries, Crichton, R.I.	8.38	...	<i>Ork.</i>	Pomona, Deerness	2.73	69
120	" Eskdalemuir Obs.	11.26	194	<i>Shet.</i>	Lerwick	5.86	138
73	<i>Roeb.</i> Branhholm	6.11	185	<i>Cork.</i>	Caheragh Rectory	11.35	...
108	<i>Selk.</i> Ettrick Maunse	10.84	199	"	Dunmany Rectory	12.70	205
"	<i>Peob.</i> West Linton	4.44	...	"	Ballinacurra	10.08	251
144	<i>Berk.</i> Marchmont House	3.81	127	"	Glanmire, Lota Lo.	10.34	241
133	<i>Hadd.</i> North Berwick Res.	3.34	149	<i>Kerry.</i>	Valentia Obsy.	12.27	225
147	<i>Midl.</i> Edinburgh, Roy. Obs.	4.16	193	"	Gearahameen	18.70	...
159	<i>Lan.</i> Auchtyfardle	5.95	...	"	Killarney Asylum	12.05	215
"	<i>Ayr.</i> Kilmarnock, Kay Pk.	6.80	...	"	Darrynane Abbey	10.48	205
205	" Girvan, Pinnore	10.77	202	<i>Wat.</i>	Waterford, Brook Lo.	9.63	255
144	<i>Renf.</i> Glasgow, Queen's Pk.	6.64	178	<i>Tip.</i>	Nenagh, Cas. Lough	7.23	180
205	" Greenock, Prospect H.	8.97	140	"	Roscrea, Timoney Park	8.40	...
"	<i>Bute.</i> Rothesay, Ardenraig	10.46	206	"	Cashel, Ballinamona	8.91	252
165	" Dougarie Lodge	8.84	...	<i>Lim.</i>	Foynes, Coolnanes	5.46	134
206	<i>Arg.</i> Ardour House	12.08	...	"	Castleconnel Rec.	7.07	...
"	" Maunse of Glenorchy	...	...	<i>Clare.</i>	Inagh, Mount Callan	8.65	...
191	" Oban	8.60	156	"	Broadford, Hurdlest'n.	6.49	...
127	" Poltalloch	9.10	162	<i>Wexf.</i>	Gorey, Courtown Ho.	8.37	240
"	" Inveraray Castle	10.29	122	<i>Kilk.</i>	Kilkenny Castle	7.51	244
126	" Islay, Eallabus	7.23	134	<i>Wic.</i>	Rathnew, Clonmannon	7.22	...
178	" Mull, Benmore	20.40	...	<i>Carl.</i>	Hacketstown Rectory	7.03	180
124	" Tiree	6.58	...	<i>Leix.</i>	Blandsfort House	8.34	249
64	<i>Kinr.</i> Loch Leven Sluice	6.21	173	"	Mountmellick	7.57	...
88	<i>Perth.</i> Loch Dhu	14.70	169	<i>Off.Ty.</i>	Birr Castle	6.16	199
"	" Balquhider, Stronvar	11.93	...	<i>Kild'r.</i>	Monasterevin	6.42	...
123	" Crieff, Strathleam Hyd.	8.66	199	<i>Dubl.</i>	Dublin, FitzWm. Sq.	3.82	143
89	" Blair Castle Gardens	6.40	182	"	Balbriggan, Ardgillan	6.65	231
177	<i>Angus.</i> Kettins School	5.33	191	<i>Me'th.</i>	Beauparc, St. Cloud	5.60	...
129	" Dundee, E. Necropolis	4.82	198	"	Kells, Headfort	6.17	181
"	" Pearsie House	7.45	...	<i>W.M.</i>	Moate, Coolators	4.51	...
177	" Montrose, Sunnyside	5.98	226	"	Mullingar, Belvedere	6.69	196
170	<i>Aber.</i> Braemar, Bank	6.69	174	<i>Long.</i>	Castle Forbes Gdns.	6.03	167
"	" Logie Coldstone Sch.	3.58	117	<i>Gal.</i>	Ballynahinch Castle	10.83	181
"	" Aberdeen, King's Coll.	4.39	149	"	Galway, Grammar Sch.	5.03	...
104	" Fyvie Castle	3.45	100	<i>Mayo.</i>	Mallaranny	8.91	...
43	<i>Moray.</i> Gordon Castle	2.28	79	"	Westport House	9.21	188
55	" Grantown-on-Spey	2.24	75	"	Delphi Lodge	17.46	176
59	<i>Nairn.</i> Nairn, Delnies	1.47	62	<i>Sligo.</i>	Markree Obsy.	6.64	159
134	<i>Invs.</i> Ben Alder Lodge	8.60	...	<i>Car'n.</i>	Belturbet, Cloverhill	4.96	159
"	" Kingussie, The Birches	3.94	...	<i>Ferm.</i>	Enniskillen, Portora	5.54	...
"	" Loch Quoich, Loan	12.75	...	<i>Arm.</i>	Armagh Obsy.	4.70	166
"	" Glenquoich	11.96	98	<i>Down.</i>	Fofanny Reservoir	14.16	...
78	" Inverness, Culduthel R.	1.66	...	"	Seaforde	7.99	211
85	" Arisaig, Faire-na-Squir	6.52	...	"	Donaghadee, C. Stn.	6.61	217
59	" Fort William	11.01	...	"	Banbridge, Milltown	5.07	...
171	" Skye, Dunvegan	8.39	...	<i>Antr.</i>	Belfast, Cavehill Rd.	5.88	...
23	<i>R & C.</i> Alness, Ardross Cas.	3.12	78	"	Glenarm Castle	6.86	...
"	" Ullapool	3.18	60	"	Ballymena, Harryville	6.33	156
48	" Torridon, Bendamph	...	...	<i>Lon.</i>	Londonderry, Creggan	4.45	109
86	" Achnashellach	5.87	...	<i>Tyr.</i>	Omagh, Edenfel.	4.84	127
"	" Stornoway	4.88	...	<i>D.n.</i>	Malin Head	4.86	...
35	<i>Suth.</i> Lairg	2.14	54	"	Dunfanaghy	4.66	...
"	" Tongue	2.04	44	"	Killybegs, Rockmount	6.34	101

* For Indian stations a rain day is a day on which 0.1 in. or more rain has fallen.

Climatological Table for the British Empire, June, 1931.

STATIONS	PRESSURE		TEMPERATURE						Relative Humidity	Mean Cloud Amt	PRECIPITATION			BRIGHT SUNSHINE					
	Mean of Day M.S.L.	Diff. from Normal	m.b.	Absolute			Mean Values				Amt	Diff. from Normal	Days	Hours per day	Per-cent. age of possible				
				Max.	Min.	° F.	Max.	Min.								° F.	1/2 max. and min.	Diff. from Normal	° F.
London, Kew Obsy.	1017.1	+ 0.4	77	45	68.7	53.1	60.9	54.6	+ 1.7	54.5	80	7.8	1.66	—	0.19	10	5.8	35	
Gibraltar	1017.0	+ 0.4	91	55	82.2	63.6	72.9	62.3	+ 2.4	62.3	80	3.8	0.20	—	0.28	4	..	..
Malta	1017.2	+ 2.0	99	62	84.4	70.5	77.5	69.3	+ 4.8	69.3	67	2.5	0.04	—	0.05	1	12.5	86	
St. Helena	1017.6	+ 1.4	69	55	64.1	57.1	60.6	58.0	+ 0.1	58.0	92	8.2	2.51	..	..	15	..	..
Sierra Leone	1015.1	+ 3.1	90	66	85.2	70.6	77.9	77.6	+ 2.4	77.6	88	5.8	13.20	—	0.81	25	..	..
Lagos, Nigeria	1011.8	+ 1.1	90	71	84.5	74.9	79.7	76.6	+ 0.4	76.6	84	9.3	17.73	—	0.92	20	..	..
Kaduna, Nigeria	1014.6	+ 0.8	91	65	88.3	69.5	78.3	73.4	+ 2.4	73.4	83	7.3	7.21	—	0.61	16	..	..
Zomba, Nyasaland	1019.3	+ 1.8	77	48	70.0	53.1	61.5	..	+ 1.4	..	67	5.1	0.05	—	0.43	1	..	..
Salisbury, Rhodesia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cape Town	1024.2	+ 4.1	79	33	63.6	45.6	54.6	46.9	+ 1.1	46.9	85	4.8	1.18	—	3.32	11	..	..
Johannesburg	1024.8	+ 2.6	68	29	61.8	41.6	51.7	39.8	+ 1.0	39.8	88	1.4	0.16	—	0.02	1	9.6	91	
Mauritius	1018.9	+ 0.1	81	63	77.7	67.1	72.4	68.5	+ 3.0	68.5	72	3.8	2.07	—	0.73	17	8.4	77	
Calcutta, Alipore Obsy.	999.9	+ 0.2	102	76	95.3	81.4	88.3	82.2	+ 3.2	82.2	87	6.2	6.02	—	5.89	9	..	..
Bombay	1004.9	+ 0.9	95	75	91.3	81.3	86.3	79.5	+ 2.3	79.5	78	5.8	6.08	—	13.79	8	..	..
Madras	1003.1	+ 0.7	108	75	100.4	82.4	91.4	76.9	+ 1.4	76.9	59	5.2	3.25	—	1.28	4	..	..
Colombo, Ceylon	1009.4	+ 0.8	87	75	85.6	77.6	81.6	78.1	+ 0.9	78.1	83	8.8	10.60	—	3.28	29	5.2	42	
Singapore	1009.5	+ 0.6	93	73	88.3	76.9	82.6	78.3	+ 0.7	78.3	82	6.8	10.17	—	3.32	14	6.4	53	
Hongkong	1005.6	+ 0.4	90	72	88.8	75.0	81.9	77.7	+ 0.2	77.8	82	8.6	11.60	—	4.25	18	4.5	33	
Sandakan	..	..	92	72	88.8	75.0	81.9	77.7	+ 0.2	77.8	82	..	8.25	—	0.75	15	..	..
Sydney, N.E.W.	1019.9	+ 2.0	80	40	64.3	48.7	56.5	50.1	+ 1.8	50.1	77	5.2	2.26	—	2.18	12	5.6	57	
Melbourne	1019.1	+ 0.6	61	33	56.5	44.5	50.5	47.1	+ 0.1	47.1	85	8.3	3.85	—	1.79	19	2.3	23	
Adelaide	1020.0	+ 0.9	63	38	59.3	47.1	53.2	48.6	+ 0.3	48.6	79	9.1	5.16	—	2.36	20	3.0	31	
Perth, W. Australia	1020.1	+ 2.1	71	37	60.8	44.8	52.8	48.1	+ 0.0	48.1	73	4.9	6.54	—	0.40	12	5.7	57	
Coolgardie	1020.9	+ 2.0	71	32	59.0	38.9	48.9	44.4	+ 0.3	44.4	70	5.3	0.71	—	1.45	9	..	..
Brisbane	1021.7	+ 3.4	79	46	70.9	53.8	62.3	56.0	+ 2.1	56.0	75	5.6	0.57	—	2.20	10	6.5	63	
Hobart, Tasmania	1015.4	+ 1.1	60	34	52.7	42.6	47.7	43.5	+ 0.7	43.5	80	6.6	3.36	—	1.13	16	3.5	38	
Wellington, N.Z.	1016.9	+ 2.0	58	35	51.3	41.8	46.5	44.2	+ 0.7	44.2	79	6.9	3.71	—	0.94	17	3.7	40	
Suva, Fiji	1015.0	+ 1.4	86	65	79.7	69.6	74.7	70.8	+ 0.0	70.8	80	6.7	3.34	—	3.37	17	4.1	37	
Apia, Samoa	1011.5	+ 0.3	86	68	83.6	73.3	78.5	75.6	+ 0.7	75.6	79	5.8	10.65	—	5.30	13	6.5	58	
Kingston, Jamaica	1013.0	+ 0.8	93	71	89.3	75.1	82.2	74.4	+ 0.9	74.4	81	6.6	2.78	—	1.32	12	5.5	42	
Grenada, W.I.	1013.3	+ 0.0	89	70	85.8	72.8	79.3	72.9	+ 0.3	72.9	75	7.5	12.93	—	4.08	28	..	..
Toronto	1015.9	+ 0.7	91	43	75.7	56.1	65.9	60.1	+ 2.1	60.1	71	4.3	2.16	—	0.50	8	9.1	59	
Winnipeg	1009.6	+ 2.2	87	37	74.8	53.3	64.1	54.1	+ 1.8	54.1	77	4.7	2.55	—	0.56	11	9.1	56	
St. John, N.B.	1014.3	+ 0.8	87	37	67.0	50.9	58.9	54.8	+ 2.4	54.8	85	8.0	2.46	—	0.81	10	6.7	43	
Victoria, B.C.	1017.2	+ 0.4	82	45	63.9	49.4	56.7	52.3	+ 0.3	52.3	75	6.1	0.66	—	0.18	6	9.1	57	

Source: British Empire Meteorological Service, 1931.

Victoria, B.C.	1017.2	+	0.4	82	37	45	63.9	67.0	50.9	49.4	50.7	+	2.4	54.8	85	8.0	—	0.81	10	6.7	40
																75	6.1	0.06	0	0.1	57	

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